CLAIMS

1. A method for inducing a mucosal immune response, comprising:

administering to a mucosal surface of a subject an effective amount for inducing a mucosal immune response of an oligonucleotide, having a sequence including at least the following formula:

$$5' X_1 X_2CGX_3 X_4 3'$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the mucosal immune response, and wherein the antigen is not encoded in a nucleic acid vector.

2. The method of claim 1, wherein the subject is actively exposed to the antigen.

3. The method of claim 2, wherein the antigen is delivered to a mucosal surface.

4. The method of claim 2, wherein the antigen is administered concurrently with the oligonucleotide.

5. The method of claim 2, wherein the antigen is delivered in conjunction with a colloidal dispersion system.

6. The method of claim 5, wherein the colloidal dispersion system is selected from the group consisting of macromolecular complexes, nanocapsules, microspheres, beads, and lipid-based systems.

7. The method of claim 6, wherein the lipid-based system is selected from the group consisting of oil-in-water emulsions, micelles, mixed micelles, and liposomes.

8. The method of claim 2, further comprising the step of administering a non-oligonucleotide mucosal adjuvant in conjunction with the antigen.

9. The method of claim 8, wherein the non-oligonucleotide mucosal adjuvant is selected from the group consisting of cholera toxin, derivatives of cholera toxin, labile toxin, derivatives

of labile toxin, alum, MLP, MDP, saponins such as QS21, cytokines, oil-in-water and other emulsion formulations such as MF59, SAF, Montanide ISA 720 and PROVAX, PCPP polymers, and ISCOMS.

10. The method of claim 1, wherein the subject is passively exposed to the antigen.

11. The method of claim 10, wherein the subject is a subject at risk of developing an allergic reaction.

12. The method of claim 10, wherein the subject is a subject at risk of developing an infectious disease.

13. The method of claim 11, wherein the subject is at risk of developing cancer.

14. The method of claim 1, wherein the oligonucleotide is 8 to 100 nucleotides in length.

15. The method of claim 1, wherein the oligonucleotide includes a phosphate backbone modification which is a phosphorothioate or phosphorodithioate modification.

16. The method of claim 15, wherein the phosphate backbone modification occurs at the 5' end of the oligonucleotide.

17. The method of claim 15, wherein the phosphate backbone modification occurs at the 3' end of the oligonucleotide.

18. The method of claim 1, wherein X_1X_2 are nucleotides selected from the group consisting of: GpT, GpG, GpA, ApA, ApT, ApG, CpT, CpA, CpG, TpA, TpT, and TpG; and X_3X_4 are nucleotides selected from the group consisting of: TpT, CpT, ApT, TpG, ApG, CpG, TpC, ApC, CpC, TpA, ApA, and CpA.

19. The method of claim 1, wherein the oligonucleotide has a sequence including at least the following formula:

$$5' \text{ TCNTX}_1\text{X}_2\text{CGX}_3\text{X}_4 \text{ 3'}$$

wherein X_1, X_2, X_3, and X_4 are nucleotides, N is a nucleic acid sequence composed of from about 0-25 nucleotides.

20. The method of claim 1, wherein the antigen is selected from the group consisting of cells, cell extracts, proteins, polypeptides, peptides, polysaccharides, polysaccharide conjugates, peptide mimics of polysaccharides, lipids, glycolipids, carbohydrates, allergens, viruses and viral extracts and muticellular organisms such as parasites.

21. The method of claim 1, wherein the antigen is an allergen.

22. The method of claim 1, wherein the antigen is derived from an infectious organism selected from the group consisting of infectious bacteria, infectious viruses, infectious parasites, and infectious fungi.

23. The method of claim 1, wherein the subject is an asthmatic.

24. The method of claim 1, further comprising administering a cytokine to the subject.

25. The method of claim 1, further comprising administering a B-7 costimulatory molecule.

26. The method of claim 1, wherein the mucosal immunity is induced in a remote site.

27. The method of claim 1, further comprising administering a boost of oligonucleotide.

28. The method of claim 8, further comprising administering a boost of the oligonucleotide and the non-oligonucleotide mucosal adjuvant.

29. A method for inducing a mucosal immune response, comprising

administering to a mucosal surface of a subject an effective amount for inducing a mucosal immune response of an antigen and a plasmid vector, having a sequence including at least the following formula:

$$5' X_1 X_2CGX_3 X_4 3'$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides.

30. The method of claim 29, wherein the antigen is not encoded in a nucleic acid vector.

31. The method of claim 29, wherein the antigen is encoded by a nucleic acid vector.

32. The method of claim 31, wherein the antigen is encoded by the plasmid vector.

33. The method of claim 29, wherein the plasmid vector includes a nucleic acid sequence which operatively encodes for a cytokine.

34. The method of claim 29, wherein the antigen and the plasmid vector are administered orally.

35. The method of claim 29, wherein the mucosal immunity is induced in a remote site.

36. The method of claim 29, wherein at least 50μg of the plasmid vector is administered to the subject.

37. The method of claim 29, further comprising the step of administering a non-oligonucleotide mucosal adjuvant in conjunction with the antigen.

38. The method of claim 37, wherein the non-oligonucleotide mucosal adjuvant is selected from the group consisting of cholera toxin, derivatives of cholera toxin, labile toxin, derivatives of labile toxin, alum, MLP, MDP, saponins such as QS21, cytokines, oil-in-water and other emulsion formulations such as MF59, SAF, Montanide ISA 720 and PROVAX, PCPP polymers, and ISCOMS.

39. The method of claim 29, further comprising administering a boost of oligonucleotide.

40. The method of claim 37, further comprising administering a boost of the oligonucleotide and the non-oligonucleotide mucosal adjuvant.

41. The method of claim 29, wherein X_1X_2 are nucleotides selected from the group consisting of: GpT, GpG, GpA, ApA, ApT, ApG, CpT, CpA, CpG, TpA, TpT, and TpG; and X_3X_4 are nucleotides selected from the group consisting of: TpT, CpT, ApT, TpG, ApG, CpG, TpC, ApC, CpC, TpA, ApA, and CpA.

42. The method of claim 29, wherein the oligonucleotide has a sequence including at least the following formula:

$$5' \text{ TCNTX}_1\text{X}_2\text{CGX}_3\text{X}_4 \text{ 3'}$$

wherein X_1, X_2, X_3, and X_4 are nucleotides, N is a nucleic acid sequence composed of from about 0-25 nucleotides.

43. The method of claim 29, wherein the oligonucleotide is 8 to 100 nucleotides in length.

44. The method of claim 29, wherein the oligonucleotide includes a phosphate backbone modification which is a phosphorothioate or phosphorodithioate modification.

45. The method of claim 44, wherein the phosphate backbone modification occurs at the 5' end of the oligonucleotide.

46. The method of claim 44, wherein the phosphate backbone modification occurs at the 3' end of the oligonucleotide.

47. A method for inducing a mucosal immune response, comprising

administering to a mucosal surface of a subject an effective amount for inducing a mucosal immune response of an antigen and of an oligonucleotide, having a sequence including at least the following formula:

$$5' \text{ X}_1\text{ X}_2\text{CGX}_3\text{ X}_4 \text{ 3'}$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and wherein the antigen is encoded by a nucleic acid vector.

48. The method of claim 47, wherein the antigen and the oligonucleotide are administered orally.

49. The method of claim 47, wherein the mucosal immunity is induced in a remote site.

50. The method of claim 47, wherein at least 50μg of the plasmid vector is administered to the subject.

51. The method of claim 47, further comprising the step of administering a non-oligonucleotide mucosal adjuvant in conjunction with the antigen.

52. The method of claim 51, wherein the non-oligonucleotide mucosal adjuvant is selected from the group consisting of cholera toxin, derivatives of cholera toxin, labile toxin, derivatives of labile toxin, alum, MLP, MDP, saponins such as QS21, cytokines, oil-in-water and other emulsion formulations such as MF59, SAF, Montanide ISA 720 and PROVAX, PCPP polymers, and ISCOMS.

53. The method of claim 47, further comprising administering a boost of oligonucleotide.

54. The method of claim 47, further comprising administering a boost of the oligonucleotide and the non-oligonucleotide mucosal adjuvant.

55. The method of claim 47, wherein the oligonucleotide has a backbone selected from the group consisting of a phosphodiester backbone and a chimeric backbone.

56. The method of claim 47 wherein the oligonucleotide has a phosphorothioate backbone.

57. The method of 56 wherein plasmid and oligonucleotides are delivered with a colloidal dispersion system.

58. The method of 57 wherein the colloidal dispersion system is selected from the group consisting of macromolecular complexes, nanocapsules, microspheres, beads, and lipid-based systems.

59. The method of 56 wherein plasmid and oligonucleotide are coated onto gold particles and are delivered with a gene-gun.

60. The method of claim 47, wherein X_1X_2 are nucleotides selected from the group consisting of: GpT, GpG, GpA, ApA, ApT, ApG, CpT, CpA, CpG, TpA, TpT, and TpG; and X_3X_4 are nucleotides selected from the group consisting of: TpT, CpT, ApT, TpG, ApG, CpG, TpC, ApC, CpC, TpA, ApA, and CpA.

61. The method of claim 47, wherein the oligonucleotide has a sequence including at least the following formula:

5' TCNTX$_1$X$_2$CGX$_3$X$_4$ 3'

wherein X_1, X_2, X_3, and X_4 are nucleotides, N is a nucleic acid sequence composed of from about 0-25 nucleotides.

62. The method of claim 47, wherein the oligonucleotide is 8 to 100 nucleotides in length.

63. The method of claim 47, wherein the oligonucleotide includes a phosphate backbone modification which is a phosphorothioate or phosphorodithioate modification.

64. The method of claim 62, wherein the phosphate backbone modification occurs at the 5' end of the oligonucleotide.

65. The method of claim 62, wherein the phosphate backbone modification occurs at the 3' end of the oligonucleotide.

66. A method for inducing a mucosal immune response in a subject, comprising:

administering to a subject an antigen and an effective amount for inducing a mucosal immune response of an oligonucleotide, having a sequence including at least the following formula:

5′ X$_1$ X$_2$CGX$_3$ X$_4$ 3'

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

administering to the subject a hormone to induce the mucosal immune response.

67. The method of claim 66, wherein the antigen and the oligonucleotide are administered to a mucosal surface of the subject.

68. The method of claim 66, wherein the hormone is administered systemically.

69. A method for inducing an immune response, comprising

orally administering to a subject an effective amount for inducing an immune response of an oligonucleotide, having a sequence including at least the following formula:

$5' X_1 X_2CGX_3 X_4 3'$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the immune response.

70. The method of claim 69, wherein the antigen is administered orally.

71. The method of claim 69, wherein the antigen is administered simultaneously with the oligonucleotide.

72. The method of claim 69, wherein the oligonucleotide is administered in an effective amount for inducing mucosal immunity.

73. A method for inducing an immune response, comprising

orally administering to a subject an effective amount for inducing an immune response of a CpG containing plasmid, having a sequence including at least the following formula:

$5' X_1 X_2CGX_3 X_4 3'$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the immune response.

74. The method of claim 73, wherein the antigen is administered orally.

75. The method of claim 73, wherein the antigen is administered simultaneously with the CpG containing plasmid.

76. The method of claim 73, wherein the oligonucleotide is administered in an effective amount for inducing mucosal immunity.

77. A method for inducing an immune response, comprising

intranasally administering to a subject an effective amount for inducing an immune response of an oligonucleotide, having a sequence including at least the following formula:

5′ X_1 X_2CGX_3 X_4 3'

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the immune response.

78. The method of claim 77, wherein the antigen is administered intranasally.

79. The method of claim 77, wherein the antigen is administered simultaneously with the oligonucleotide

80. The method of claim 77, wherein the oligonucleotide is administered in an effective amount for inducing mucosal immunity.

81. A method for inducing an immune response, comprising

rectally administering to a subject an effective amount for inducing an immune response of an oligonucleotide, having a sequence including at least the following formula:

5′ X_1 X_2CGX_3 X_4 3'

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the immune response.

82. The method of claim 81, wherein the antigen is administered rectally.

83. The method of claim 81, wherein the antigen is administered simultaneously with the oligonucleotide.

84. The method of claim 81, wherein the oligonucleotide is administered in an effective amount for inducing mucosal immunity.

85. A method for inducing an immune response, comprising

vaginally administering to a subject an effective amount for inducing an immune response

of an oligonucleotide, having a sequence including at least the following formula:

$$5' X_1 X_2CGX_3 X_4 3'$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the immune response.

86. The method of claim 85, wherein the antigen is administered vaginally.

87. The method of claim 85, wherein the antigen is administered simultaneously with the oligonucleotide.

88. The method of claim 85, wherein the oligonucleotide is administered in an effective amount for inducing mucosal immunity.

89. A method for inducing an immune response, comprising

ocularly administering to a subject an effective amount for inducing an immune response of an oligonucleotide, having a sequence including at least the following formula:

$$5' X_1 X_2CGX_3 X_4 3'$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject to an antigen to induce the immune response.

90. The method of claim 89, wherein the antigen is administered ocularly.

91. The method of claim 89, wherein the antigen is administered simultaneously with the oligonucleotide.

92. The method of claim 89, wherein the oligonucleotide is administered in an effective amount for inducing mucosal immunity.

93. A method for inducing a systemic immune response, comprising

administering to a mucosal surface of a subject an effective amount for inducing a systemic

immune response of an oligonucleotide, having a sequence including at least the following formula:

$$5' X_1 X_2CGX_3 X_4 3'$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

administering to the mucosal surface of the subject an antigen to induce the systemic immune response.

94. The method of claim 93, wherein the antigen is delivered in conjunction with a colloidal dispersion system.

95. The method of claim 94, wherein the colloidal dispersion system is selected from the group consisting of macromolecular complexes, nanocapsules, microspheres, beads, and lipid-based systems.

96. The method of claim 95, wherein the lipid-based system is selected from the group consisting of oil-in-water emulsions, micelles, mixed micelles, and liposomes.

97. The method of claim 93, further comprising the step of administering a non-oligonucleotide mucosal adjuvant in conjunction with the antigen and the oligonucleotide.

98. The method of claim 97, wherein the non-oligonucleotide mucosal adjuvant is selected from the group consisting of cholera toxin, derivatives of cholera toxin, labile toxin, derivatives of labile toxin, alum, MLP, MDP, saponins such as QS21, cytokines, oil-in-water and other emulsion formulations such as MF59, SAF, Montanide ISA 720 and PROVAX, PCPP polymers, and ISCOMS.

99. The method of claim 93, wherein the oligonucleotide is 8 to 100 nucleotides in length.

100. The method of claim 93, wherein the oligonucleotide includes a phosphate backbone modification which is a phosphorothioate or phosphorodithioate modification.

101. The method of claim 100, wherein the phosphate backbone modification occurs at the 5' end of the oligonucleotide.

102. The method of claim 100, wherein the phosphate backbone modification occurs at the

3' end of the oligonucleotide.

103. The method of claim 93, wherein X_1X_2 are nucleotides selected from the group consisting of: GpT, GpG, GpA and ApA and X_3X_4 are nucleotides selected from the group consisting of: TpT, CpT or TpC.

104. The method of claim 93, wherein the oligonucleotide has a sequence including at least the following formula:

$$5' \text{ TCNTX}_1\text{X}_2\text{CGX}_3\text{X}_4 \text{ 3'}$$

wherein X_1, X_2, X_3, and X_4 are nucleotides, N is a nucleic acid sequence composed of from about 0-25 nucleotides.

105. The method of claim 93, wherein the antigen is selected from the group consisting of cells, cell extracts, proteins, polypeptides, peptides, polysaccharides, polysaccharide conjugates, peptide mimics of polysaccharides, lipids, glycolipids, carbohydrates, allergens, viruses and viral extracts and muticellular organisms such as parasites.

106. The method of claim 93, wherein the antigen is an allergen.

107. The method of claim 93, wherein the antigen is derived from an infectious organism selected from the group consisting of infectious bacteria, infectious viruses, infectious parasites, and infectious fungi.

108. The method of claim 93, wherein the antigen is not encoded in a nucleic acid vector, and wherein the antigen does not produce a systemic immune response when administered to the mucosal surface alone.

109. A method for inducing a systemic immune response, comprising

administering to a mucosal surface of a subject an effective amount for inducing a systemic immune response of a combination of a non-oligonucleotide mucosal adjuvant and an oligonucleotide, having a sequence including at least the following formula:

$$5' \text{ X}_1 \text{ X}_2\text{CGX}_3 \text{ X}_4 \text{ 3'}$$

wherein C and G are unmethylated, wherein X_1, X_2, X_3, and X_4 are nucleotides, and

exposing the subject an antigen to induce the systemic immune response.

110. The method of claim 109, wherein the subject is actively exposed to the antigen and wherein the antigen is delivered in conjunction with a colloidal dispersion system.

111. The method of claim 110, wherein the colloidal dispersion system is selected from the group consisting of macromolecular complexes, nanocapsules, microspheres, beads, and lipid-based systems.

112. The method of claim 111, wherein the lipid-based system is selected from the group consisting of oil-in-water emulsions, micelles, mixed micelles, and liposomes.

113. The method of claim 110, wherein the antigen is delivered to a mucosal surface.

114. The method of claim 113, wherein the non-oligonucleotide mucosal adjuvant is selected from the group consisting of cholera toxin, derivatives of cholera toxin, labile toxin, derivatives of labile toxin, alum, MLP, MDP, saponins such as QS21, cytokines, oil-in-water and other emulsion formulations such as ME59, SAF, Montanide ISA 720 and PROVAX, PCPP polymers, and ISCOMS.

115. The method of claim 109, wherein the oligonucleotide is 8 to 100 nucleotides in length.

116. The method of claim 109, wherein the oligonucleotide includes a phosphate backbone modification which is a phosphorothioate or phosphorodithioate modification.

117. The method of claim 116, wherein the phosphate backbone modification occurs at the 5' end of the oligonucleotide.

118. The method of claim 116, wherein the phosphate backbone modification occurs at the 3' end of the oligonucleotide.

119. The method of claim 109, wherein X_1X_2 are nucleotides selected from the group consisting of: GpT, GpG, GpA and ApA and X_3X_4 are nucleotides selected from the group consisting of: TpT, CpT or TpC.

120. The method of claim 109, wherein the oligonucleotide has a sequence including at least the following formula:

$$5' \text{ TCNTX}_1\text{X}_2\text{CGX}_3\text{X}_4 \text{ 3'}$$

wherein X_1, X_2, X_3, and X_4 are nucleotides, N is a nucleic acid sequence composed of from about 0-25 nucleotides.

121. The method of claim 109, wherein the antigen is selected from the group consisting of cells, cell extracts, proteins, polypeptides, peptides, polysaccharides, polysaccharide conjugates, peptide mimics of polysaccharides, lipids, glycolipids, carbohydrates, allergens, viruses and viral extracts and muticellular organisms such as parasites.

122. The method of claim 109, wherein the antigen is an allergen.

123. The method of claim 109, wherein the antigen is derived from an infectious organism selected from the group consisting of infectious bacteria, infectious viruses, infectious parasites, and infectious fungi.

124. The method of claim 109, wherein the antigen is not encoded in a nucleic acid vector.